Projectile Motion:

- Treat the x- and y-directions independently

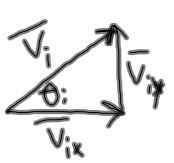
- Assumptions:
  - Object is in free-fall
  - Ignore air resistance

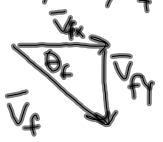
- Variables:
  - x-direction:

    $\Delta x,\ v_{ix},\ v_{fx},\ a_x\ (=0\ m/s^2)$
  - y-direction:

    $\Delta y,\ v_{iy},\ v_{fy},\ a_y = a_g = 9.8\ m/s^2$ downward
  - both directions

    $t,\ \theta_i,\ \theta_f,\ v_i,\ v_f$





- Equations:

$\Delta x = v_{ix}t + \frac{1}{2}a_x t^2 \Rightarrow \Delta x = v_{ix}t$

$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \Rightarrow v_{fx}^2 = v_{ix}^2$

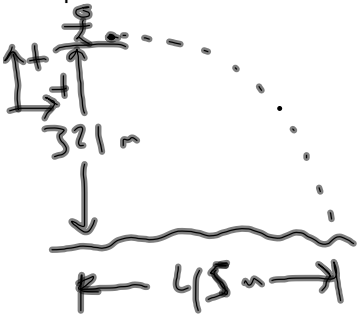
$v_{fx} = v_{ix} + a_x t \Rightarrow v_{fx} = v_{ix}$

$\Delta y = v_{iy}t + \frac{1}{2}a_g t^2$

$v_{fy}^2 = v_{iy}^2 + 2a_g\Delta y$

$v_{fy} = v_{iy} + a_g t$

The Royal Gorge Bridge in Colorado rises 321 m above the Arkansas River. Suppose you kick a rock horizontally off the bridge. The magnitude of the rock's horizontal displacement is 45.0 m. Find the speed at which the rock was kicked.



$\Delta x = 45\ m$ $\quad v_{iy} = 0\ m/s$

$\Delta y = 321\ m$ $\quad v_{ix} = ?$

$a_x = 0\ m/s^2$ $\quad t = ?$

$$\Delta y = \cancel{v_{iy}^{0} t} + \frac{1}{2} a_g t^2$$

$$t = \sqrt{\frac{2\Delta y}{a_g}}$$

$$= 8.09\ s$$

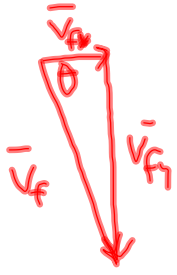
$$\Delta x = v_{ix} t$$

$$v_{ix} = \frac{\Delta x}{t} = 5.56\ m/s$$

Find v_f.

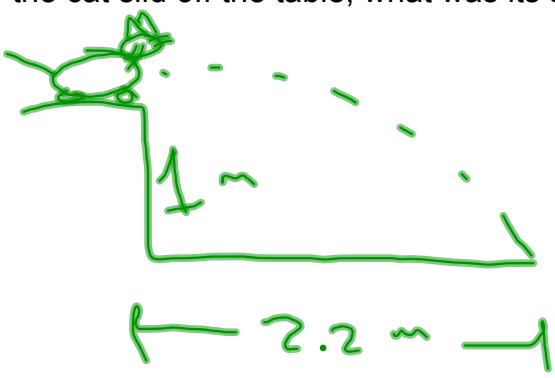
$$v_{fx} = v_{ix} = 5.56\ m/s$$

$$v_{fy} = \cancel{v_{iy}^{0}} + a_g t = -79.3\ m/s$$



$\vec{v}_f = 79.5\ m/s$ @ 86.0° S of E

A cat chases a mouse across a 1.0 m high table. The mouse steps out of the way, and the cat slides off the table and strikes the floor 2.2 m from the edge of the table. When the cat slid off the table, what was its speed?



$\Delta x = 2.2\ m$

$\Delta y = 1\ m$

$v_{iy} = 0\ m/s$

$v_{ix} = ?$

$$\Delta y = v_{iy} t + \frac{1}{2} a_g t^2$$

$$t = \sqrt{\frac{2\Delta y}{a_g}}$$

$$= .452\ s$$

$$\Delta x = v_{ix} t$$

$$v_{ix} = \frac{\Delta x}{t}$$

$$= 4.87\ m/s$$